28° Fahr. Penguins were about in great numbers, and no difficulty was experienced in killing some of them.

On the 14th December, in latitude 66° 44′ S. and longitude 164° 0′ E., as the *Antarctic* approached Balleny Island, the ice floes greatly increased in size, and some of them were observed to carry stones and earth. So thick and dangerous was the ice that a vessel, dependent wholly upon sails, could not have existed, and even with steam those on board ran very considerable risk, and had one or two narrow escapes. They decided to run eastward, following in the track of the *Erebus* and *Terror.* On Christmas Eve they saw the midnight sun in latitude 66° 47′ S. and longitude 174° 8′ E., and at midnight on the 31st December the sun was again shining brightly.

Altogether they were thirty-eight days in working their way through the pack ice, and then they got into a clear, smooth, open expanse of sea. They steered straight for Cape Adare in Victoria Land, which they first sighted on Jan. 16. Mr. Borchgrevink describes it as a square bluff of basaltic rock. The temperature of the air here was 32°, and of the water 30°, and the sky was perfectly clear. Cape Adare rose to a height of 3,779 feet. Near Mount Sabine a peak was sighted clear of snow, considered to be a volcano recently in eruption.

On January 18th, they sighted Possession Island, where Sir James Ross landed fifty-four years before and planted the British flag. They found an immense quantity of penguins, and a large portion of the island, which they judged to be about three hundred and sixty acres in extent, was covered with a deep layer of guano. Small plants were found there by Mr. Borchgrevink growing on the rocks up to thirty feet above sea level. These have subsequently been identified as lichens.

On the 20th February they steamed still further southward, and sighted a new cape which they named Cape Oscar, in honour of the King of Sweden and Norway, whose birthday it happened to be. On the 22nd they were in latitude 74° S., and no whales being visible they decided to return northwards to Cape Adare, where they landed, being the first human beings who had ever set foot on that territory. Their landing place was a sort of peninsula, which formed a complete breakwater for the inner bay, through which they steered. Immense swarms of penguins were on the cape, on which they nested as high up as 1,000 feet. Mr. Borchgrevink and his party after landing, collected specimens of the rock, and they also found some signs of vegetation, consisting of lichens (?) like those met with by them at Possession Island.

Throughout the whole of their voyage they had a comparatively high temperature, and they met with great numbers of sperm whales. The minimum temperature which they encountered within the Antarctic circle was 25° Fahr., and the maximum was 46°, while all through the ice pack it kept at 28°. The mean temperature for January 1895 was 32·5° Fahr., and for February 30° Fahr.

While at Possession Island and Cape Adare Mr. Borchgrevink collected specimens of the different varieties of rock obtainable at those localities. Several of the specimens from Cape Adare are in the form of waterworn pebbles, which were picked up by Mr. Borchgrevink on the shores of that headland.

(3) *Summary of Antarctic Geology.*—The observations of the Antarctic explorers mentioned above prove that (*a*) eruptive, (*b*) sedimentary, and (*c*) metamorphic rocks are well represented in Antarctica. If the (*a*) *Eruptive rocks* be divided into respectively plutonic, and volcanic groups, we find that the former comprises granite, pegmatite, granulites rich in microcline and muscovite, syenite, diorite, diabase etc., and the latter pumice, andesites partly hornblendic, augite-labradorite rocks (augite-andesites ?), basalts, basic scoriæ, palagonite tuffs.

(*b*) *Sedimentary rocks*—These comprise the *Cucullæa* rocks of Cape Seymour, with fossil wood of Lower Tertiary Age, numerous fragments of limestone, partly molluscan, partly foraminiferal, the latter Tertiary, the former of doubtful geological age, some more or less incoherent, some oolitic, some in the condition of marble. Besides these are the fragments of hard yellowish magnesian limestone with *Gyroporella*, probably Triassic, the Palæozoic (?) greyish-white limestones of the South Orkneys, fragments of various sandstones, arkose, quartzites, and clay shales.

(*c*) *Metamorphic rocks*—These appear to be abundantly represented and comprise :—gneisses, some hornblendic, containing zircon, microcline, sphene, apatite, rutile, tourmaline etc., mica-schists with tourmaline, microcline, sphene and epidote; sericite quartz-schists, epidotic quartz-schists rich in rutile, argillaceous schist with crystals of biotite and garnet, and numerous particles of graphite, phyllite schists and talc schists.

With regard to the volcanic zone of Antarctica the following is a list of the volcanoes at present known to us :—

1. Balleny Island	...Dormant (?)...	... 12,000 feet	high.
2. Buckle Island	...Active (?) ...	... Small.	
3. Mount Sabine	...Extinct (?) ...	... 9,500 feet	„
4. Cone observed by Borchgrevink near Mt. Sabine apparently recently in eruption, Active (?).			
5. Mount Herschell	...Extinct ...	... 14,000 feet (?)	„
6. Mount Melbourne	...Extinct(? large crater).		
7. Mount Erebus	...Active ...	... 12,367 feet (?)	„
8. Mount Terror	...Extinct (?) ...	... 10,884 feet	„
9. Mount Haddington	Extinct (?) ...	... 7,050 feet	„
10. Cockburn Island	...Extinct (?) ...	... 2,750 feet	„
11. Paulet Island	...Active ...	... 750 feet	„
12. Etna Island	...Extinct (?) ...	... 1,300 feet	„
13. Bridgman Island	...Active cone	... 400 feet (?)	„
14. Apsland Island	...Extinct crater.		
15. Astrolabe Island	...Extinct crater	... 1,000 feet (?)	„
16. Deception Island—Large partly submerged crater with numerous fumaroles, dormant (?)		800 – 1,800 ft.	„
17. Christensen Volcano	Active ...	... Small.	
18. Sarsee Volcano	... Active ...	...	„

19. Lindenberg Volcano Extinct (?)... ... Small

20. 21. 22. 23. } The four Seal Islands, extinct (?) ... „

As regards the general distribution of these volcanoes, we may here quote from a previous paper by one of us forming part of his Presidential Address to the Linnean Society of New South Wales for 1895, pp. 155 - 156 :—"The volcanoes of Victoria Land show a tendency to linear arrangement. From Mount Sabine to Mount Melbourne the trend is south-south-westerly. Mount Erebus and Mount Terror lie almost due south of Mount Sabine. Further north from Mount Sabine the great earth-fold, on the *septum* of which this chain of volcanoes is situated, probably bends a little westwards, as shown partly by the surroundings, partly by the position of Balleny's Island. North-west of Balleny's Island the great fold trends perhaps to the knotting point between the Tasmanian axis of folding, described in the address just referred to, and that of New Zealand, the former perhaps running through Royal Company Island, and the latter through or near Auckland Island and Macquarie Island. The knotting point would probably be somewhere (approximately) near the intersection of the 60th parallel of south latitude with the 150th meridian of longitude east from Greenwich. It would thus join the line of extinct volcanoes along East Australia on the west, and perhaps the active volcanic zone of the North Island of New Zealand, or at all events the fold which bounds that continent, on the east.

Traced in the opposite direction, the volcanic zone probably runs through Seal Islands, the active volcanoes of Christensen and Sarsee, and through Mount Haddington, an extinct volcano in Trinity Land, to Paulet and Bridgman Islands, active volcanoes. The volcanic zone bends easterly from here on account of the easterly trend in the fold, which appears to make a loop towards South Georgia before it swings back towards Cape Horn. That there is a real easterly trend in the earth-fold at Trinity Land

and the South Shetlands is proved by the observations made by the *Astrolabe* and *Zélée* expedition, which record a strike in a north-north-east and south-south-west direction for the greyish-white limestones and phyllite-schists at the South Orkneys. Towards Cape Horn from near South Georgia the fold probably trends west-north-westerly, then follows an approximately meridional direction parallel with the chain of the Andes. It may be noted, however, that whereas the *Erebus* chain of Victoria Land is on the east side of the fold, the Christensen-Bridgman group are apparently on the opposite side. This may be due to the fact that at the latter locality the eastern slope of the fold is steeper than the western, as seems probable from the presence of the deep ocean abyss east of Graham's Land, as shown on Dr. Murray's map. It is probable, therefore, that the volcanic chain of Victoria Land will continue towards the South Pole, probably bending somewhat to the eastward, and will thence change its position to the fold on the other side of the Antarctic continent, so as to run through the Christensen-Bridgman line of volcanoes. In any case it is almost certain that high land, covered of course more or less by snow and glaciers, will be found at the South Pole."

The additional information as to the geology of Antarctica furnished by the collections submitted to us by Mr. Borchgrevink is detailed below :—

Part II.—Petrology of the Rocks collected by Mr. C. E. Borchgrevink from Cape Adare, Victoria Land, and from Possession Island.

A.—Specimens from Cape Adare.

Garnetiferous-Granulitic-Aplite, (No. 4).

This rock is the only representative of the acid-group among the specimens. In the mass it is a white, holocrystalline, aggregate of quartz and felspar granules. Numerous small, well-crystallized red garnets are present, also numerous crystals of black tourmaline. In section the granulitic texture is very marked, and the felspar granules are seen to consist largely of microcline. The hatched twin lamellæ are very irregular and wavy and suggest that the rock has been under pressure. There is a small amount of triclinic felspars which appears to lie between albite and oligoclase. One section of the latter shows a remarkable twin structure (*Plate* 13, fig. 1), the outline is rudely rectangular and the grain is divided into four equal areas by lines joining the middle points of the sides. Each area is finely lamellar, and extinguishes simultaneously with the one diagonally opposite to it. A possible explanation may be that it is a section approximately parallel to the macropinacoid (100) divided into two halves according to the Carlsbad law, and again divided into two halves, one of which is reversed on the other by turning round a normal to 001, according to the Mannebach law. In addition to this each of the four areas exhibit albite lamellation. Some of the felspars show numerous fine parallel cavities probably of the nature of solution planes.

The quartz grains have some liquid enclosures but not many, and also some very fine needles of a mineral which has not been determined. Stray flakes of muscovite have been noticed.

Among the accessory minerals the garnets do not require further notice. The tourmaline occurs in well shaped prisms the pleochroism being pale pinkish-brown to very dark slaty-purple.

Included in the other minerals are numerous highly refracting grains and prisms, all practically colourless. Some of these must be referred to topaz, although the optical sign appears to be negative instead of positive, as is more usual. One piece in particular, (*Plate* 13, figs. 2*a*, 2*b*) has the outline of a cross section of topaz and gives a good figure in convergent light. In this, from the shape of the section, it can be seen that the optic axial plane is the macropinacoid, and that the sign is negative while the axial angle is somewhat smaller than usual. If this mineral is a topaz, it would appear that in addition to the change of sign, the plane of the optic axes has taken a position at right angles to the normal one. It is an interesting point in connexion with this, that we have found, among some sections cut for stauroscopic investigation, a specimen of topaz in which the optic axes make a very small angle with each other (not more than a few degrees) and that the optical sign is negative. It may be that under certain conditions topaz changes its axial angle, and after passing through zero the axes open out in a plane at right angles to their former position with changed sign.

Besides some apatites and zircons there are some grains with extremely strong double refraction. One of these, a small prism showing pyramid faces at one end, gives colours of the seventh order in polarized light (*Plate* 13, fig. 3). The presence of some prismatic cleavage lines render it probable that it is rutile.

There are a few tabular crystals of anatase, and some grains, with somewhat lower double refraction and without cleavage, may most probably be referred to cassiterite.

Trachyte, (Nos. 1 and 2).

Compact, greenish-grey in colour, somewhat fissile. Sp. gr. 2·49.

Analysis yielded the following composition :—

SiO_2	= 61·01
Al_2O_3	= 16·62
Fe_2O_3	= 3·55
FeO	= 2·81
MnO	= ·55
CaO	= 3·27
MgO	= ·06
Na_2O	= 5·92
K_2O	= 5·22
Water (ignition)	= 1·13
	100·14

Phosphoric acid and chlorine present in small quantities.

Under the microscope the rock is seen to be composed principally of sanidine microlites. There is a small proportion of lath-shaped triclinic microlites and of cryptocrystalline interstitial material.

(*Plate* 14, fig. 1). The sanidines are apparently all tabular in form, some slices showing nothing but tabular sections while others yield only lath-shaped ones.

The ferro-magnesian constituent is represented by an ægirine which is present in considerable quantity (probably nearly 25% of the whole bulk). It exhibits brownish-green to bluish-green pleochroism with a small extinction angle. It is uniformly distributed in minute angular patches moulded on the felspars with here and there a tendency to an elongated prismatic habit. In places it shows ophitic structure on a small scale. The only porphyritic constituents are a few rounded grains of this same ægirine and a few large grains of magnetite.

As accessory constituents there are a number of minute flakes of a brown biotite, some needles of apatite included in the felspars, a few zircons and a little magnetite.

Glassy Augite Andesite (?) No. 11.

Greyish-black in the mass and has the appearance of a fine grained andesite or basalt.

There are but few porphyritic constituents. Some corroded fragments of felspar, apparently monoclinic, and some grains of a pale augite with faint pleochroism—yellowish- to pinkish-brown. There are one or two patches of magnetite (opacite) granules with traces of brown hornblendic material remaining.

Next to these in point of size we have a sparsely scattered crop of small lath-shaped felspars, the majority of which are simply twinned, but a few show lamellar twinning and appear to be oligoclase. The base appears to be glassy, but is generally not quite isotropic and gives the impression of being in a state of strain. It is quite colourless and in many places indefinite plates of felspar material seem to have partially developed.

This base is filled with very minute augite crystals. They are for the most part well formed crystals, with short prismatic habit, pale green in colour, and appear to have a small angle of extinction.

They are too minute to be certain of pleochroism. In addition to these there is much magnetite dust.

This rock ought perhaps to be classified as a trachytic andesite owing to the number of apparently monoclinic felspars present. The amount of glassy base present renders its nomenclature a matter of uncertainty which can only be settled by chemical analysis for which there has not been time up to the present.

Vesicular Andesite Glass, No. 13.

This is a highly vesicular fragment which on examination proves to have many points in common with the glassy andesite No. 11, and may well be considered as a portion of the same flow. The porphyritic constituents are quite similar to those in No. 11, with the exception that we have here some hornblendes preserved with a ring of opacite granules round them, while in No. 11 the hornblende has practically completely disappeared. The lath-shaped felspars are not so numerous, but are still for the most part simply twinned. The base is faintly coloured and somewhat more glassy while the incipient felspar plates are not noticed.

The minute augite crystals are perhaps quite as numerous as in No. 11, but are even smaller while the magnetite and opacite dust is more diffused.

Basaltic Andesite (No. 6).

In the mass fine-grained, very dark grey in colour, with but few porphyritic crystals. Sp. gr. 2·78.

In sections the ground mass is cryptocrystalline, and contains a dust of magnetite and minute augite granules. Above this in the scale of crystallization is a crop of forked triclinic microlites, giving extinction angles approximating to labradorite. There are also many small square and rectangular sections of felspar, most of which show only simple twinning.

Some large crystals of magnetite are present, and a number of medium sized yellowish brown augites. One or two grains of olivine were noticed enclosed in augite. There are also some corroded crystals of a rich brown hornblende, which are surrounded by a ring of magnetite (opacite) dust, which varies in amount from a thin layer to a complete absorption of the original mineral. (*Plate* 14, fig. 3.)

Olivine-Dolerite, No. 14.

This rock has suffered considerable alteration. The felspars are lath-shaped, not much decomposed, but the broken and irregular lamellæ give evidence of considerable crushing. These felspars have a tendency to aggregate into radial or fan-shaped groups which might be considered as a poor attempt at 'centric' or 'ocellar' structure.

The augite is brown in colour, the depth increasing toward the periphery of the grain. It occurs in irregular grains partly moulded on the felspars, and giving rise in places to ophitic structure. Most of it is fairly fresh, but in places it has been converted into a felted mass of chlorite fibres, and possibly also serpentine or other ferruginous silicates.

The olivine is in large grains, frequently with idiomorphic contours. These have for the most part been converted into serpentine, without separation of magnetite dust, but coloured in patches by homogeneous aggregates of chlorite fibres.

Magnetite crystals are present, together with irregular masses of secondary magnetite. Specular hæmatite seems to be present also, the brilliant faces of the crystals being noticeable in reflected light; some of this is possibly micaceous ilmenite.

Numerous slender needles of apatite traverse all other constituents, and there are needles of what appears to be an actinolithic mineral also present.

Olivine Basalt (Nos. 3*a*, 3*b*).

Compact, greyish-black with phenocrysts of augite, olivine, and plagioclase. Sp. gr. 2·92.

In section the rock is clear and fresh. The ground-mass fine in texture and composed of plagioclase microlites, minute grains of brownish-green augite moulded on the felspars, and magnetite dust.

The porphyritic constituents are :—Plagioclase (chiefly labrodorite), some of the crystals being zoned and others appear to be made up of patches of felspar of different composition, forming a large lath-shaped section. Some of these patches have all the appearance of sanidine. Augite, pale brown in section with idiomorphic contours. Olivine, generally in rounded grains, occasionally idiomorphic, and showing no alteration to speak of. There are also some large grains of magnetite. Some of these have a coarsely arborescent structure, the spaces between the branches being occupied by felspar and augite similar to the ground-mass. This would seem to point to the constituents of the ground-mass having started to crystallize before the grains of magnetite had completely separated out. (*Plate* 14, fig. 2.)

Olivine Basalt, (No. 7).

This specimen is a vescicular pebble of a reddish-brown colour. Sp. gr. 3·07.

Under the microscope the rock is seen to consist of a fine-grained ground-mass much stained with ferruginous decomposition products, and carrying numerous phenocrysts of augite, olivine and magnetite. The scarcity of felspar is at once apparent, no crystals of any appreciable size being present. The ground-mass however, contains a considerable number of very small felspar microlites. These together with much very finely granular augite and magnetite dust make up the ground-mass, little if any glass being discernible.

At first the comparative scarcity of felspar would suggest that the rock approached a limburgite in composition. The following analysis shows that it must be retained in the basalt group :

SiO_2 = 45·13%
Al_2O = 18·13
Fe_2O_3 = 12·94
CaO = 11·23

MgO	=	7·33
K_2O	=	·98
Na_2O	=	2·14
H_2O	=	2·18
		100·06

The percentage of Al_2O_3 is high and implies the presence of felspar, either actual or potential. As there is little glass present it is probable that the augite, which is by far the most prevalent constituent, is itself highly aluminous.

The porphyritic augites are frequently broken but not much corroded. All exhibit shelly zoning, there being generally two or three thin shells round each crystal. In some cases where the crystal has been fractured these shells continue round the fractured edge, showing that they have formed subsequently to the breaking of the original kernel. This kernel is frequently twinned and is greenish-yellow in colour. The angle $c : \mathfrak{c} = 45°$; this increases in other outer shells up to 55° in the outermost. Zoning is apparent in ordinary light, owing to the outer shell being of a decided yellow colour, but whether this is due to change in composition or merely to staining is not clear, though the former is probable, from the sharpness and uniformity of the coloured shell. One crystal differs from the majority in having a well marked shell with a greater angle of extinction than the kernel and outside this a thin shell having the same extinction as the kernel.

The olivine is all porphyritic, idiomorphic outlines being common. All the crystals exhibit a curious structure. They are traversed by a dense rectangular network composed of strings of magnetite grains which here and there show octahedral faces but are less regular than skeleton crystals. (*Plate* 13, fig. 4.)

The main axes of these strings are apparently parallel to the axes, *a*, and *b*, the shorter offsets being parallel to the vertical axis. The olivine matrix is perfectly colourless and fresh, showing no decomposition and none of the usual irregular cracks. In places there are thin films of what is probably micaceous hæmatite making the olivine a brilliant transparent red.

In many of the crystals the enclosed iron oxides have been attached and converted into opaque red hæmatite, so that the whole crystal appears of an opaque red by reflected light. The larger crystals of magnetite have suffered in the same way, and the opaque red dust has spread over much of the ground-mass.

Limburgite (No. 9).

In the mass this rock is of a dark grey colour, compact with minute irregular cavities, and shows phenocrysts of augite and olivine. Sp. gr. 2·94.

It has very much the appearance of an ordinary olivine basalt. On microscopic examination, however, felspar was found to be entirely absent. Porphyritic augites and olivines are abundant; they are clear and fresh, and show crystal boundaries. These augites are yellowish to pinkish-brown in colour, generally zoned and frequently twinned. Then we have a large crop of much smaller augites with a few small olivines, and finally there is a base of fine granular augite and greyish to brown intersertal glass dusted over with granules of magnetite. (*Plate* 15, fig. 3.)

The colour of the glass varies in patches; in places it seems almost entirely absent, and elsewhere we find it in brown angular patches filling the spaces between the second generation of augites. This glass is perfectly isotropic, but contains a dust of dark particles. Throughout the mass there are little irregular cavities which would appear to be contraction rifts consequent on crystallization. Into these the augites of the second generation project with very good crystal boundaries. These cavities are filled with a colourless isotropic mineral with a few needle-like inclusions. This is most probably analcime. Treated micro-chemically with HCl it is decomposed, yielding a good crop of NaCl crystals and gelatinous SiO_2. The separated silica is richly stained by malakite green.

As to the nomenclature of this specimen, its mineralogical constitution practically entitles it to a place among the limburgites, though it is undoubtedly more stony in texture than is usual with these rocks.

A partial analysis gave the following results :—

$$SiO_2 = 38{\cdot}44\%$$
$$Al_2O_3 = 19{\cdot}88$$
$$Fe_2O_3 = 13{\cdot}46$$

Some oxide of manganese is included with the alumina. This shows that the rock is ultrabasic in composition. The high percentage of alumina is accounted for by the analcime which is present in considerable quantity.

Limburgite, (No. 10).

This rock is not unlike No. 9 in general appearance, but its texture is finer. Sp. gr. 2·91.

Under the microscope it is seen to be a highly glassy rock, the glass being very free from crystallites and of a rich brownish-yellow colour. Contained in the base are porphyritic augites and olivines, and a second generation of smaller augites similar to No. 9. Numerous small granules of magnetite are also present. (*Plate* 15, fig. 4).

It is possible that this rock is but a more glassy portion of the mass from which No. 9 has come, and that this glass holds potentially the granular augitic base which is seen developed in the latter rock.

A partial analysis, for comparison with No. 9, gave the following :—

$$SiO_2 = 38{\cdot}99\%$$
$$Al_2O_3 = 11{\cdot}72$$
$$Fe_2O_3 = 15{\cdot}26$$

The percentage of alumina in this is much less than in No. 9, and probably represents more accurately the common magma, as in this rock no analcime, so prevalent in the other, is observed.

Basic Tuff, (No. 8*a*, 8*b*).

A hardened tuffaceous material, light-brown in colour, containing numerous darker angular fragments. Under the microscope is seen to be composed of numerous irregular fragments of various basic volcanic glasses. These vary in colour from light to dark brown, and are all amygdaloidal, the vescicles being filled or partially filled with colourless isotropic material. Some of the lighter fragments are almost pumiceous in texture, while a few consist of almost compact dark brown glass.

All the fragments contain minute lath-shaped felspars with a parallel arrangement in each piece, while the more glassy ones contain trichites in addition. The matrix is comminuted material of the same nature as the fragments, and contains a few large angular pieces of felspar.

No. 8*c* is very similar to the foregoing but is more porous, the vesicles being without amygdaloidal infillings.

Nos. 12 and 15 are fragments of scoriaceous lavas, some of which approach pumice in character. They are probably of intermediate composition, but have not been examined in detail.

Mica Schist, (No. 5.)

A fine grained rock, consisting of quartz and dark brown mica, with strongly marked schistose characters and easily fissile. In thin sections the rock appears to be made up principally of clear granules of quartz and flakes of biotite (*Plate* 14, fig. 4). The biotite forms about 20% of the whole mass and is perfectly fresh and strongly pleochroic. In addition to these constituents there is a small amount of a white mica which appears to be muscovite. There are also numerous small but beautifully formed prisms of brown tourmaline as well as zircon, apatite, magnetite, some pseudomorphs of pyrites in oxide of iron, and a few grains of a green spinel, probably pleonaste. Some felspar is also present, and possibly a member of the scapolite group.

The bulk analysis of the rock yielded the following results:—

SiO_2 ...	=71·43%
Al_2O_3 (P_2O_5)	=11·03
Fe_2O_3 ...	= 1·81
FeO ...	= 2·56
MnO ...	= ·52
CaO ...	= 4·07
MgO ...	= 2·44
Na_2O ...	= 2·10
K_2O ...	= 2·77
H_2O (on ignition)	= 1·44
	100·17

Phosphoric acid, chlorine and fluorine are present in small quantities.

The percentage of lime is notably large and a partial analysis of the biotite was made to see whether it contained any lime. This yielded the following:—

SiO_2	=37·70%
Al_2O_3	=20·74
Fe_2O_3	=19·03
MnO	= 2·03
MgO	= 8·06

The iron present as FeO was not determined. It was found to contain no lime.

The above analysis shows that the mica, which has a decided bronze lustre, lies between biotite and lepidomelane in composition. It was also found to be uniaxial. The high percentage of MnO is noteworthy and probably accounts for all the manganese found in the bulk analysis of the rock. (We may mention incidently that all the specimens of these Antarctic rocks which have so far been submitted to analysis contain appreciable quantities of manganese).

Lime being therefore excluded from the mica it became necessary to search for it elsewhere. No trace of twinning, which would indicate a felspar, is to be found among the colourless granules; nevertheless some of them were found to be biaxial in convergent polarized light. Further, in the neighbourhood of joint planes, some of these granules are seen to be slightly decomposed, indicating that they are silicates and not quartz.

These silicates, from their resemblance to the quartz grains, when not decomposed, may be either felspars or scapolites or both. The fact that many of them are biaxial may reasonably be taken as indicating felspar, notwithstanding the absence of twinning, for the secondary felspars in schists are frequently untwinned and much resemble quartz in thin sections. The question then arises as to whether a member of the scapolite group is also present. To try and settle this, a prolonged separation of the mineral constituents was made. A few heavy minerals came down first, then the tourmaline; close on this came the dark mica, and immediately after it the muscovite. The bulk of the rock, which now consisted of colourless grains only, remained. For a long time we tried to separate this into its different constituents but failed, as they all floated or sank together. It followed therefore that the quartz, felspar and other silicates, not only resembled each other under the microscope but were also of equal density.

Separation by this method having failed, and the silicates being but slightly attacked by acids, the isolation and identification of a scapolite (if present) is not feasible. Nevertheless certain general arguments render the presence of such a mineral very probable. In the first place a felspar with the sp. gr. of quartz would have a composition approaching that of oligoclase or andesine. In such a felspar the proportion of CaO does not exceed that of Na_2O, and if we assumed that all the Na_2O was present in felspar, this would account for only 2·1% of CaO, leaving a balance of 1·97% unaccounted for. We are therefore in need of a silicate which, under the microscope resembles quartz, has the same sp. gr. as quartz, and in which the amount of CaO, or the proportion of CaO to Na_2O, is large.

Now certain members of the scapolite group are the only minerals with which we are acquainted which entirely satisfy the conditions, and on these grounds we think it highly probable that such a mineral is present.

The question of the pre-metamorphic condition of a schist, such as the present one, is of great interest, but unfortunately little can be done towards its elucidation from mere hand specimens. One or two suggestions may, however, be made. From the bulk analysis this mica schist appears to have the composition of an acid igneous rock so far as its more stable constituents (SiO_2 and Al_2O_3) go. In other constituents there are important differences. For example, the amount of CaO and of MgO is largely in excess of, and the amount of alkalis falls far short of, that usual in acid igneous rocks. Now this diminution of the alkalis and increase of the alkaline earths is suggestive of denudation and sedimentation, and lends colour to the suggestion that this rock may be a metamorphosed sediment.

Again the numerous tourmalines present indicate, probably, thermal metamorphism under the influence of an highly heated acid rock from which boric acid and fluorine might be derived. (In the granulitic aplite No. 4, we have evidence of the presence of such an igneous mass—containing much tourmaline—in the district). One may therefore suggest with some probability that this mica-schist has been previously a sedimentary rock which has taken its present form under the influence of a neighbouring mass of highly heated acid magma.

B.—Specimens from Possession Island.

Amygdaloidal Trachyte, (No. 9).

Grey in colour with numerous irregular cavities, many of which are filled with yellowish and white materials. The texture is uniform, giving in section a mass of small lath-shaped felspars which appear to be sanidine and oligoclase. Between these there is a fair amount of colourless glass containing magnetite and very minute grains of highly-refracting greenish material, probably augite. The flow structure is distinct, and the cavities and amygdaloids are irregularly elongated parallel to its direction. These amygdaloids consist of a very irregular layer of brownish doubly-refracting material which fuses easily and gelatinizes easily with HCl even in the cold, and is most probably natrolite.

The portions inside this layer are generally filled with colourless sectors of material which exhibits faint anomalous double-refraction, and may probably be analcime. In some of the larger ones the centre is occupied by calcite surrounded by analcime which is again surrounded irregularly by natrolite. The natrolite exists in minute fan-shaped aggregates.

Augite Andesite, (No. 12).

Rock brownish in colour, considerably decomposed and porous. Small red grains indicate oxidation of magnetite crystals, and the general brownish tone due to oxidation of magnetite dust. There is not much actual staining of other constituents. Under the microscope appears to be an andesite of fine texture.

The base consists of felspar microlites, a great number of smaller prisms and grains of yellow augite and magnetite (mostly converted to reddish oxides), and a fair amount of granular intersertal glass, almost colourless and containing highly refracting globulites. There are some porphyritic crystals of brownish augite the outer shells of which are of a strong yellow colour similar to that of the small augites in the base. This is probably due to oxidation of the FeO. There are some dark patches in the base, some with regular outlines, which may represent the debris of another constituent, possibly a hornblende.

Basalt, (Nos. 1 and 2).

These are specimens of a fine, dark, compact basalt, with a few porphyritic crystals of black augite. Sp. gr. 2·82, 2·86.

In section, flow structure is apparent from the parallel arrangement of the small lath-shaped felspars. The texture is microcrystalline with a certain amount of intersertal glass of a brownish colour. Numerous small brownish-red olivines are present as well as minute crystals and grains of a pale augite, and much magnetite dust. The glass contains numerous globulites and microlites, but nothing of special interest.

Basalt, (Nos. 3 and 7.)

These specimens seem identical, save that No. 3 is slightly vesicular, while No. 7 is fairly compact. Colour greyish-black. Base glassy with patches of finely granular augite. Small lath-shaped felspars abundant, also small brownish-red olivines. Porphyritic constituents scanty, consisting of one or two rich brown hornblendes surrounded by a considerable resorption layer of opacite granules mixed with granules of augitic material; and a few fair sized grains of a greenish augite. These specimens bear a strong resemblance to Nos. 1 and 2 in mineralogical constitution.

Basalt, (No. 5.)

Fine in texture with glassy base containing magnetite, minute pale augite, felspar microliths, and some small olivines decomposing into brownish-yellow serpentine. The usual small lath-shaped felspars are present; some porphyritic grains of pale augite, and some pseudomorphs of hornblende in opacite and augite granules. One of these represents a large crystal of hornblende, and some of the original mineral remains. This is clear and fresh, and shows a greenish-yellow to brown pleochrism (*Plate* 15, fig. 1). Near the centre of the pseudomorph a large patch of the rock base is included. The constitution of this pseudomorph is peculiar. There is an outer zone of opacite, and almost colourless augite granules preserving the idiomorphic outline of the original hornblende. Inside this there is a zone of varying width formed of fucoid-like growths standing at right-angles to the sides. These are dark brown in colour, translucent, and slightly pleochroic (?), and apparently traversed by strings of opacite granules. It is probable that they consist of thin leaves of a brown oxide of iron.

Basalt, (No. 6).

Fine in texture, with glassy base nearly colourless and containing numerous globulites and grains of highly refracting material, which is probably augite. Also magnetite dust, a large crop of lath-shaped felspar microlites and many small brownish-red olivines. Porphyritic constituents absent. There is, however, in one of the sections a crystal of zoisite, about 0·75 mm. long by 0·5 mm. broad (*Plate* 15, fig. 2). This is perfectly colourless and conspicuous by its very low double-refraction, high index of refraction, and rhombic characters. The section is six-sided, showing two prism faces and four pyramid faces. The cleavage parallel to 010 is well shown and a series of somewhat curved parting planes at right angles to the vertical axis. In this particular section the greater elasticity is parallel to the axis *c*. There are some smaller sections of this mineral giving rhombic and trapezoidal outlines.

Basalt, (No. 8).

This rock in the mass presents a curious foliated appearance. It seems to be made up of little irregular ovoid lumps, about 5 mm. by 2 to 3 mms., together with less regular fragments into which it easily breaks up. The ovoid pieces all lie with their longer axes parallel and a face at right angles to these axes was polished. It was then seen that the ovoid lumps gave rise to dull round spots fairly regularly distributed over this surface. They are of softer material than the portions surrounding them, and form centres from which irregular cracks radiate out through the surrounding layers (*Plate* 13, fig. 8).

It would thus appear that the rock has split up into a number of irregular ovoid lumps, the longer axes of which are all parallel, that most of these have a kernel of softer material the outer evelope being traversed by irregular radial cracks. We have not seen anything exactly like this structure before, and no definite explanation has up to the present suggested itself. Doubtless contraction on cooling together with lateral pressures and subsequent percolation of waters along the cracks to the kernels have done their share in its formation. In thin sections the slice splits up into a number of rounded and polygonal pieces, but no distinction is observable between those forming the kernels and those forming the surrounding shells. The rock is a fine grained basalt composed of a felted mass of felspar microlites with minute grains of greenish augite, magnetite, and brownish-red olivines. The presence of any glassy material is doubtful. The texture is very fine and quite uniform, no phenocrysts having been met with.

All the basalts described so far bear a striking resemblance to each other, both in general characters and in mineralogical constitution. Their differences consist in the varying amount of glassy base and slight changes of texture, some having a few porphyritic constituents, and some being vesicular.

The small brownish-red grains of olivine form a peculiar feature common to all. Were it not for these olivines, the general characters of these lavas, and the fact that most of the felspars indicate a composition not lower in the series than labradorite, would suggest that they should be placed among the basaltic andesites. On the other hand the olivine is not present in sufficient quantity to make them olivine-basalts. In the absence of chemical analysis their exact classification is not ascertainable, and we have therefore left them with the somewhat indefinite designation of basalt.

Olivine Basalt, (No. 10).

A dark scoriaceous rock with numerous large olivines and black crystals of augite. Under the microscope the ground-mass is fine in texture, containing a number of very minute lath-shaped felspars. With higher magnifying power the base is seen to be glassy, slightly greenish-brown in colour, with numerous globulites and highly refracting grains. Intermediate in size between these and the felspars are numerous grains of pale brown augite, and also of brownish-yellow olivine. These olivines have a granular appearance. There are also many small magnetite grains.

Coming next to the porphyritic minerals we have :—Large crystals of magnetite. Large rounded grains of olivine, which are colourless but turning to a brownish-yellow along the cracks. Finally, very large crystals of augite. These have idiomorphic contours, are frequently simply twinned and slightly pleochroic. The colour varies from a greenish-brown to a violet-brown in different crystals and frequently in the same crystal. Sometimes this change of colour takes the form of zoning, the kernels being greenish and the outer shell violet, and sometimes the two colours seem irregularly intergrown.

There are also a few corroded remnants of a brown hornblende. The original hornblende crystals are in several instances represented by remarkable pseudomorphs, similar in many points to those described in Basalt No. 5. There are, however, some features present in these which render a separate description desirable.

The ground-mass of these pseudomorphs consists of granules of almost colourless augite. These granules have in their interstices or intergrown with them little specks of colourless isotropic material, numerous elongated and branching patches of dark brown to opaque material similar to the fucoid-like inclusions described in No. 5, and finally many prismatic and granular pieces of brownish-yellow olivine similar to those in the base of the rock. A small piece of the original brown hornblende may or may not remain in the centre.

The augite framework, which appears to be in irregular granules owing to the number of these inclusions in it, is in reality optically continuous. In one case it is twinned, one half of the pseudomorph extinguishing at a different angle from the other. As no hornblende remains, it cannot be ascertained whether this twinning occured in the original mineral. Further, it appears from two of the pseudomorphs that this secondary augite has its plane of symmetry coincident with that of the hornblende. In one of these (*Plate* 13, fig. 5) which appears to be a section parallel to 010, the hornblende extinguishes at an angle of 16° with the vertical axis (shown by the prismatic cleavage), while the augite extinguishes at 43° on the opposide of the vertical axis. In the other case (*Plate* 13, fig. 6) we have a section approximately at right angles to the vertical axis as shown by the shapely defined prismatic cleavages of the hornblende, and here the hornblende and augite extinguish simultaneously.

The dark brown to opaque inclusions do not occur in the original hornblende, but are confined to the surrounding altered portion. They do not appear to have any very definite arrangement, irregularly elongated and platy forms being common. On the edges, and when in thin films, they are translucent and of a dark brown colour. Associated with these are prisms and irregular patches of brownish-yellow olivine ; and in some cases a layer of this olivine appears to fringe some of the brown inclusions, and one material seems even to pass gradually into the other (*Plate* 13 fig. 7.) It is a suggestion perhaps worth making that this dark material is a silicate of iron allied to ilvaite, which would resemble a fayalite in which some of the iron was peroxidised. The transition from this to a ferrugineous olivine, or vice versa, is easily conceivable.

Nos. 11 and 13 are fragments of basic scoriæ, varying from black to red in colour. Some are very highly vesicular and may be intermediate in composition. No. 11 is more compact and most of the vesicles are lined with zeolitic material.

Summary.

The collections submitted to us by Mr. Borchgrevink, in addition to proving the existence in Victoria Land of a group of trachyte lavas containing soda-augites, and other interesting rocks such as the ultra-basic limburgites and the mica-schist already described, appear to us to strongly confirm the conclusion already arrived at by Dr. Murray and several eminent biologists as to the existence within the Antarctic Circle of an Antarctic Continent rather than an Antarctic Archipelago. The schistose and granitic rocks collected by him at Cape Adare are distinctly of continental origin, and imply a strong probability of the continuity of Victoria Land with Adélie Land.

In speaking of Mr. Borchgrevink's work we can but echo the sentiments already expressed by Dr. Murray, that it is impossible

to overestimate its importance as bearing on the whole subject of the geography and geology of Antarctica; and we here desire to express to him our warmest thanks for his courtesy in allowing us the privilege of examining and describing his collections. Our thanks are also due, for help kindly given us when preparing material for this paper, to the following :—Mr. H. S. W. Crummer, the Hon. Treasurer of the New South Wales Branch of the Royal Geographical Society of Australia; Mr. E. F. Pittman, Assoc. R.S.M., the Government Geologist; Mr. G. W. Card, Assoc. R.S.M., Mineralogist; Mr. W. S. Dun, Assistant Palæontologist and Librarian to the Geological Survey of N. S. Wales; and to the following geological students of the University of Sydney:—Miss Montefiore, Miss Flavelle, Miss Haslam, Miss Noakes, Mr. H. J. S. Brook, and Mr. Graham Officer, B.Sc.

Explanation of Plates.

PLATE XIII.

Fig. 1. Triply-twinned grain of felspar showing Carlsbad, Mannebach and Albite types. Two of the sectors are shown extinguished.

Fig. 2*a*. Basal section of topaz, showing usual position of optic axes, the sign being positive.

Fig. 2*b*. Section of topaz, in *Granulitic Aplite*, A. No. 4, showing position of optic axes, the sign being negative.

Fig. 3. Prisms of rutile and anatase from *Granulitic Aplite*, A. No. 4.

Fig. 4. Crystal of olivine, from *Olivine Basalt*, A. No. 7, with intergrown meshwork of magnetite.

Figs. 5, 6. Pseudomorphs of hornblende composed of granular augite, colourless isotropic material, brownish-yellow olivines, and dark brown to black inclusions. These latter may be oxides of iron or possibly a silicate allied to ilvaite. Some of the hornblende remains in each.

The augite granules are optically continuous and have the plane of symmetry and vertical axis coincident with those of the horblende.

Fig. 7. A portion of Fig. 6 enlarged; the dotted grains represent olivines.

Fig. 8. Polished surface of basalt B. No. 8, at right angles to axes of ovoid lumps. The softer kernels of these lumps represented by lighter spots, from which irregular cracks radiate through the surrounding harder shells.

PLATE XIV.

Fig. 1. *Trachyte* A. No. 1 and 2, composed principally of sanidine and ægirine. A porphyritic crystal of ægirine is shown × 30.

Fig. 2. *Olivine Basalt* A. No. 3*a*, 3*b*, showing, near the centre, an arborescent grain of magnetite × 45.

Fig. 3. *Basaltic Andesite* A. No. 6, showing a large brown hornblende surrounded by a layer of opacite granules × 30.

Fig. 4. *Mica Schist* A. No. 5, section at right angles to plane of foliation × 30.

PLATE XV.

Fig. 1. *Basalt* B. No. 5, with large pseudomorph of hornblende. On the left of the centre a patch of the original mineral is seen × 20.

Fig. 2. *Basalt* B. No. 6, showing crystal of zoisite × 20.

Fig. 3. *Limburgite* A. No. 9, showing miarolitic structure, the cavities being filled with analcime. The dotted crystals are olivine. The glass is in dark brown angular patches or filled with fine granular augite × 30.

Fig. 4. *Limburgite*, A. No. 10, glassy base without the fine granular augite of No. 9. This is studded with a second generation of small augites and a few olivines. Two large porphyritic augites are shown × 30.

Notes on the Rainfall of the Southern Riverina 1872 to 1894.

By Hugh Charles Kiddle, F.R. Met. Soc.

[*Read before the Royal Society of N. S. Wales, December 4, 1895.*]

In order to carry out an investigation of the rainfall of a large tract of territory, two essential conditions must be complied with, firstly, there must be a number of willing observers, well distributed throughout the district, and secondly, some one to undertake the task of collecting and digesting the records thus made available. I have undertaken the task of doing this for southern Riverina, and in the pages which follow I have endeavoured to make this an exhaustive enquiry into the rainfall of the district lying between the Murray and the Murrumbidgee.

Out of one hundred and twenty-five stations herein discussed, the Government Astronomer has furnished me with the particulars of seventy-three stations; for the remaining fifty-two I am indebted to the proprietors of these stations who very kindly responded to my request for copies of their records.

I.—Area under consideration.
II.—Divisions.
III.—Tables.
IV.—Summary.

(I.) The district which, for the purpose of this paper, is termed the Southern Riverina, embraces all the area between the Murray and Murrumbidgee Rivers, and extending as far east as the meridian of 147° 30′. The locality to the eastward of that meridian is termed the western slopes of the southern table-land. The records of the town of Albury, situated in the extreme south-east of this area, have been omitted. The reason for doing this is that the township is surrounded by hills, a fact, which, in my opinion, considerably affects the rainfall. I mention this to show that only stations which may be said to belong to the Southern Riverina have been selected, and that the results are not simply a large collection of statistics irrespective of locality. As Albury has a very long and valuable rainfall record, you might be sure that there was a valid reason for omitting it. The area of the district is approximately 19,700 square miles, or embracing about twelve and a half millions of acres of the finest wool and wheat growing lands of New South Wales. The length is about two hundred and thirty miles, and average width about eighty-four miles. The surface may be characterised as a generally sloping plain falling from east to west. The altitudes on the eastern side are given thus for Wagga Wagga 615 feet, Albury 530 feet, the level at Deniliquin is 320 feet, while at Balranald about 230 feet, being a fall of about two feet per mile for the first interval and one foot per mile for the second.

(II.) *Divisions.*—The area has been divided into four sections, the dividing lines being the meridians of longitude. They are designated—

Section.	From.	To.
A	Junction of Rivers Murray and Murrumbidgee.	145° E.
B	145° E.	146° E.
C	146° E.	147° E.
D	147° E.	147° 30′ E.

This method of division was selected as it was found to be more workable than taking the square degree or other arbitrary unit, and it also conformed to the *geographical nature* of the district. The first three sections are essentially part of the Southern Riverina, but Section D encroaches somewhat on the southern tableland. For this reason only those stations situated on the northern, central, and western sides were used for the purpose of computing the Table No. 4.

(III.) The Tables numbered 1, 2, 3, 4, have been compiled for each year by taking the sum of the available rain records for each month in that year and dividing by the number of stations. I may say that the stations are well distributed throughout each section, so that the average for each year, although the result of a constantly increasing number of stations, is a very true one.

One pleasing feature is the large number of stations representing Section A. I have obtained twenty-nine records for 1893 for this section. In all sections where there are two or more reports from the same place, either only *one* of them, or else the average of the two has been counted in the mean. For instance Wagga Wagga has two records, both dating from 1873. In such a case I take the mean of the two records and call it *one* station. The reason is obvious, for the results would otherwise probably be misleading.

Table (1) gives monthly and annual results for all stations in Section A. Table (2) same for Section B. Table (3) same for Section C. Table (4) same for Section D.

TABLE I.—Results of Monthly and Annual Rainfall, 1872 to 1894, for Section A.—Balranald to Long. 145° E.

Year.	No. of Stations.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872	3	·37	·07	·50	·43	·92	4·05	1·31	1·24	1·35	1·93	3·28	1·27	16·72
1873	3	5·01	3·16	·10	2·29	1·40	1·29	·82	2·69	1·92	·88	·88	·65	21·59
1874	3	3·34	—	4·31	1·33	1·36	1·67	·63	·51	2·29	·50	·31	·12	16·37
1875	4	·16	2·04	·78	1·71	2·97	3·13	1·20	2·44	1·01	1·81	·57	1·37	19·19
1876	5	·65	·51	1·68	·16	2·91	·16	·10	2·07	1·01	1·31	3·77	·22	14·55
1877	9	·50	1·05	2·35	·46	1·85	1·21	·63	·12	2·62	·63	·35	·37	12·14
1878	11	—	4·53	5·96	1·83	·25	·99	2·42	·44	·61	1·77	·67	—	19·47
1879	14	21	·34	·72	1·32	1·29	·80	1·04	1·61	1·29	2·81	1·60	·60	13·64
1880	14	·61	2·36	1·48	2·87	·48	·76	·31	·54	1·41	·59	·38	·31	12·10
1881	18	1·10	1·68	1·96	·23	2·05	1·61	·40	1·18	1·57	·73	·75	·45	13·71
1882	20	·02	·02	·09	2·83	1·00	·88	1·04	1·79	0·29	2·29	2·46	·97	13·68
1883	20	·01	·66	1·67	·73	1·77	1·20	·53	1·42	1·80	1·31	·87	·30	12·27
1884	20	·31	·28	1·15	·49	1·74	1·46	·04	·53	1·06	·73	1·34	·21	9·34
1885	22	·35	1·82	·82	1·73	·59	1·41	·92	·74	2·32	·68	·17	2·08	13·63
1886	23	1·39	·06	·25	·08	1·09	·68	1·73	2·86	1·63	1·11	·57	2·57	14·02
1887	24	·26	2·38	1·47	2·21	1·09	2·63	1·61	1·36	·95	1·95	4·19	1·88	21·98
1888	27	·43	·62	·32	·41	1·77	·59	·42	·54	·98	·22	·26	·76	7·32
1889	26	2·16	2·95	—	3·73	4·12	2·11	·27	3·02	1·71	1·39	1·99	·06	23·51
1890	27	·05	·33	2·89	·76	2·18	2·69	2·62	1·46	·59	1·75	1·58	·71	17·61
1891	26	2·38	—	1·22	3·30	·88	1·77	1·52	1·99	·65	1·72	1·17	·29	16·89
1892	28	·10	·20	·23	·66	2·86	·79	1·45	1·72	1·45	3·08	1·36	·25	14·18
1893	29	·05	·01	·52	·90	3·24	1·38	·99	1·23	1·49	·78	1·89	·40	12·88
1894	26	·59	·24	2·72	1·45	·98	2·90	1·31	1·95	·88	3·52	·35	4·32	21·21
Mean	of	23	year	s ..	...	...	...	...	...	...	...	...	...	15·56

TABLE II.—Results of Monthly and Annual Rainfall, 1872 to 1894, for Section B.—Longitude 145° E. to Longitude 146° E.

Year.	No. of Stations.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872	3	·24	·28	·41	·52	1·63	4·71	1·46	1·44	1·75	2·81	3·32	·58	19·15
1873	3	5·26	3·02	·50	1·96	1·11	1·30	·50	2·27	1·56	·72	·79	·56	19·55
1874	4	2·22	—	3·09	1·47	1·71	1·95	·98	·87	2·31	·38	·02	·04	15·04
1875	5	·39	3·16	·61	1·70	3·07	4·73	2·02	2·56	1·30	1·27	·95	1·48	23·25
1876	5	·24	·79	1·49	·02	2·86	·25	·22	1·81	·87	·60	3·08	·37	12·60
1877	8	·63	·60	·81	·23	1·67	1·67	·97	·23	2·83	·49	·56	·57	11·24
1878	9	·04	5·92	4·44	1·31	·40	1·26	2·42	·79	1·93	2·65	1·47	·02	22·65
1879	12	·46	1·37	·73	2·41	·97	·76	1·56	1·56	1·46	2·87	1·66	·47	16·27
1880	14	·65	2·00	1·95	4·14	1·06	1·06	·58	·57	1·73	·92	·21	·28	15·15
1881	14	·33	2·09	4·09	·10	1·92	1·74	·45	1·06	1·45	·84	1·03	·56	15·66
1882	17	·16	·03	·10	3·12	1·59	·88	·98	2·33	·24	2·78	2·07	1·32	15·60
1883	17	·02	1·01	1·15	·62	1·96	1·56	·68	1·49	1·64	1·92	·94	·26	13·25
1884	18	·52	·42	1·03	1·12	1·41	2·26	·24	1·13	1·08	1·56	1·37	·50	12·64
1885	17	1·62	1·13	·62	2·78	·61	1·59	·81	·60	2·66	1·35	·27	1·76	15·80
1886	19	1·45	·21	.31	·15	·89	·87	1·48	3·36	1·50	1·39	·65	2·36	14·62
1887	20	·69	3·25	3·48	1·63	1·65	2·45	1·79	1·63	1·06	2·31	3·88	2·19	26·01
1888	20	·74	1·01	·28	·36	2·44	·62	·52	·63	1·18	·29	·50	1·04	9·61
1889	21	2·52	3·10	·01	3·67	5·15	3·06	·39	3·68	1·95	1·62	1·88	·28	27·31
1890	22	·05	·32	2·71	1·04	1·95	3·27	2·51	1·35	1·09	1·70	1·45	·72	18·16
1891	22	3·31	·05	2·02	3 57	1·17	2·68	2·59	1·80	1·25	1·38	1·28	·36	21·46
1892	24	·53	·19	·07	·85	2·97	·91	1·64	2·64	1·48	3·36	1·86	·28	16·78
1893	26	·04	·03	·92	1·29	3·40	1·70	1·02	1·53	1·76	1·14	1 75	·78	15·36
1894	24	·68	·48	3·42	2·30	1·89	3·70	1·82	1·78	·88	3·71	·31	2·83	23·80
Mean	of	23	year	s...	...	...	...	...	...	...	...	...	...	17·43

TABLE III.—Results of Monthly and Annual Rainfall, 1872 to 1894, for Section C.—Longitude 146° E. to Longitude 147° E.

Year.	No. of Stations.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872	2	1·00	·86	1·20	·12	3·36	6·10	2·53	·82	1·70	4·35	3·19	2·07	27·30
1873	2	3·82	2·80	·05	2·27	·91	3·10	·42	2·48	1·12	·73	·62	·29	18·61
1874	2	2·42	—	4·25	·80	3·09	2·00	1·06	1·45	2·75	·48	—	—	18·30
1875	3	·10	3·76	1·43	2·81	3·64	4·41	2·01	3·13	1·39	1·53	1·48	2·24	27·93
1876	5	·08	·65	1·35	·07	3·18	·36	·10	1·76	1·54	1·37	2·28	·41	13·15
1877	6	·77	·97	1·03	·59	1·88	2·20	1·05	·27	2·84	1·16	·83	1·07	14·66
1878	6	—	3·99	4·19	1·84	·44	1·91	2·69	·99	3·08	3·63	2·19	·03	24·98
1879	8	·47	1·71	1·38	2·59	1·53	·81	2·18	1·86	1·68	3·40	2·03	·70	20·34
1880	12	·75	1·80	2·12	4·67	1·48	1·58	·45	·74	1·77	1·54	·44	·38	17·72
1881	13	·43	2·33	3·85	·33	2·05	1·77	·48	1·15	1·40	1·05	1·18	·85	16·87
1882	18	·32	·17	·37	3·49	2·39	·78	1·16	2·69	·28	3·67	2·23	1·28	18·83
1883	21	·01	1·06	1·57	·79	1·65	1·91	1·10	1·55	1·58	2·84	1·17	·36	15·59
1884	26	·35	·54	1·08	·73	1·48	1·57	·10	·65	·98	·99	1·54	·42	10·43
1885	32	2·26	1·64	·57	1·67	·70	2·20	·59	·90	3·17	1·34	·96	1·61	17·61
1886	36	1·44	·30	·34	·40	·92	1·02	1·74	4·03	1·76	2·73	1·16	2·70	18·64
1887	41	·94	4·12	4·27	1·26	1·80	3·03	2·64	1·74	1·20	2·78	3·47	2·00	29·25
1888	43	1·10	2·19	·23	·30	2·62	·96	1·02	·86	1·00	·39	·69	1·82	13·18
1889	44	2·49	2·95	·02	2·79	5·77	3·60	·82	3·33	2·31	1·81	2·58	·60	29·07
1890	44	·09	1·36	2·74	1·04	2·58	3·04	2·45	1·42	1·65	2·04	1·64	1·44	21·49
1891	43	4·40	·11	1·97	3·16	1·24	3·23	4·06	1·58	1·34	1·42	2·19	·49	25·19
1892	43	1·54	·22	·19	1·71	2·55	1·08	1·78	3·05	1·97	2·63	2·68	·65	20·05
1893	44	·19	—	1·66	1·84	4·19	2·08	1·68	1·98	2·31	1·87	2·54	2·23	22·57
1894	44	1·09	1·02	3·82	3·50	2·26	3·83	2·72	2·22	1·40	4·00	·47	2·53	28·86
Mean	of	23	year	s...	...	...	...	...	...	...	...	...	...	20·46

TABLE IV.—Results of Monthly and Annual Rainfall, 1872 to 1894, for Section D.—Longitude 147° E. to Longitude 147° 30′ E.

Year.	No. of Stations.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872	1	1·66	1·53	2·87	·02	2·94	6·62	1·81	1·71	2·09	3·51	3·17	2·11	30·04
1873	1	3·18	1·27	—	2·65	·77	3·54	1·12	1·54	1·70	1·09	2·73	·76	20·35
1874	1	4·10	·55	4·88	2·75	2·39	3·05	3·10	2·85	3·80	1·65	·15	—	29·27
1875	1	1·22	3·20	·57	3·20	3·20	3·86	1·44	1·93	1·76	1·68	2·05	2·15	26·26
1876	2	·27	·89	1·52	—	3·62	·55	·79	2·45	1·38	1·35	2·83	·59	16·24
1877	2	1·04	·57	1·37	1·68	2·55	3·05	1·01	·55	2·80	1·33	·45	2·97	19·37
1878	2	·03	3·81	3·33	1·84	·35	3·00	3·02	1·07	2·54	4·02	2·21	·22	25·44
1879	3	·60	1·87	2·45	2·77	2·71	1·05	2·54	2·48	2·64	2·33	2·75	·43	24·62
1880	2	·82	2·26	1·77	4·00	1·54	1·81	·69	1·04	1·04	2·11	·41	·99	18·48
1881	3	·40	2·43	2·91	·55	2·55	2·60	·73	1·16	1·46	1·43	1·65	1·05	18·92
1882	4	·70	·63	·83	3·65	2·94	1·51	1·77	3·71	·50	3·38	3·32	1·56	24·50
1883	5	·05	1·41	1·98	·76	1·63	1·78	1·39	1·67	2·28	3·81	1·41	·34	18·51
1884	7	·45	·49	1·29	1·52	1·13	3·64	·52	1·46	1·12	2·00	1·52	·81	15·95
1885	9	3·59	2·60	·44	1·08	·69	2·98	·56	1·18	3·12	1·43	1·53	1·33	20·53
1886	11	1·43	·52	·47	·61	1·21	1·01	2·08	4·94	2·25	3·89	1·63	2·36	22·40
1887	11	1·26	4·58	5·39	·59	1·44	3·77	3·33	2·05	1·56	2·90	2·60	2·95	32·42
1888	12	·92	2·85	·52	·15	2·13	1·72	1·70	·72	1·48	·33	·71	2·42	15·65
1889	12	2·70	2·72	—	2·78	6·09	4·48	1·23	3·39	2·62	2·21	3·38	1·11	32·71
1890	14	·21	2·17	3·55	1·27	2·96	3·83	3·12	1·77	2·23	2·55	2·05	2·02	27·73
1891	15	5·80	·14	1·85	3·01	1·22	4·62	5·20	1·77	1·66	1·68	2·89	·59	30·43
1892	15	2·08	·28	·78	2·05	2·79	1·49	2·09	3·88	2·48	2·48	3·14	·55	24·09
1893	17	·27	—	1·41	2·00	3·91	3·71	2·64	2·28	2·50	2·51	3·04	3·33	27·60
1894	13	2·09	1·47	4·32	4·30	1·74	4·45	3·78	3·14	1·88	4·66	·66	2·87	35·36
Mean	of	23	year	s...	...		...	...	...	...	...	...	...	24·21

(IV.) *Summary.*—In dealing with a subject so uncertain as rainfall, the most important feature to be discovered is its periodicity. In fact I think that this is the only point of importance in connection therewith.

The question of periodicity has been dealt with by many writers, and the number of different theories advanced is somewhat perplexing. There are periods of three, five, eleven, nineteen and thirty-three years; all of these have their supporters. In many instances an agreement exists between one of these periods and the figures representing the rainfall, and this agreement is immediately set forth as a positive theory. As it is orthodox to assume that rainfall is governed by certain laws, more or less proven, argument on the matter is out of place in these notes. Suffice it to say that I do not consider that the records of twenty-three years which I have now set before you, show definitely any periodicity, for the simple reason that I do not think the observations cover a sufficiently long series of years to actually prove anything. I beg to draw your attention though to the fact that the amounts of the annual totals coincide closely and conform to the period set down as a nineteen year cycle. By taking the monthly values I find that the period shows eighteen years two months. For instance, the dry period commencing in October 1874, and lasting for four months is repeated in December 1892, when a dry period of three months set in.

The annual results agreeably conform to the nineteen year cycle as shown by the following examples:—1875, 1894, and the three years immediately preceding these years respectively. These are, what may be called all good years or years of a plentiful rainfall. Unfortunately our series for this district does not give us an opportunity of comparing the recurrence of the dry years.

I think I am correct in stating that the nineteen year period originated with our Government Astronomer Mr. H. C. Russell, F.R.S. I mention this to show the excellence of the authority I quote when applying the cycle to this discussion.

The periodicity may therefore be summed up as indicative of a recurrence of similar seasons at intervals of about eighteen or nineteen years. Taken alone this knowledge may prove of much service to both the pastoralist and the agriculturalist, and if so, one of the objects aimed at will have been accomplished. But apart from the knowledge of the periodicity, these tables afford the means of working out the relationship between the amount of rainfall and the resulting crops. This may be effected by comparing the amount registered in any particular season, that is from ploughing time to harvest of any particular year, with the recorded average yield per acre of the crop under consideration. For instance bushels per acre would be assumed in discussing wheat crops, tons per acre if vines.

The tables are particularly useful in this respect, as by dividing the period the crop is in the ground into sections, the most beneficial amount of rainfall and opportune season for it to fall may be discovered. A wheat crop for instance, may be divided into (1) ploughing and sowing period, (2) growing period and, (3) ripening period. The fact that the same annual amount of rainfall will not necessarily produce the same result in the crops in any two years is so apparent as to need no enlargement thereon.

In conclusion I may say that although the period of twenty-three years is short from a meteorological point of view, the results deduced therefrom will I hope be found not altogether unworthy of notice.

At some future period I hope to be in a position to place before you not only the rainfall results of this district, but results of the investigation of rainfall, pressure, temperature, winds, etc., combined, and not only for this district but also for any other in which it may be my lot to reside.

Finally, before I close my remarks, I must take the opportunity of thanking all those gentlemen who have supplied me with copies of their records; without their assistance this paper could not have been produced. I must also thank the Government Astronomer,